Update on Washington State School Seismic Safety Assessment

to the Capital Budget Committee

February 5, 2019

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Summary of Project

- Evaluate a representative sample of school buildings for geologic and engineering hazards (220 buildings total, 15 of which received engineering concept-level seismic upgrade designs). Funded by the 2017-2019 capital budget
- Extrapolate results to other similar schools statewide
- Determine what it may cost to complete these seismic assessments statewide
- Determine what it may cost to get public school buildings seismically upgraded to meet current seismic safety standards

WASHINGTON STATE SCHOOL SEISMIC SAFETY FACTS

WASHINGTON HAS ALL THREE TYPES OF EARTHQUAKES

Shallow Crustal Earthquakes
(e.g. M7.0 Seattle Fault, M7.4 South Whidbey Island Fault)

Subduction Zone Earthquakes
(e.g. M9.0 Cascadia Subduction Zone)

Deep Earthquakes
(e.g. 2001 M6.8 Nisqually Earthquake)

IN THE NEXT 50 YEARS

10-20% *probability of an M9.0+ event*

80% *probability of an M6.0+ event*

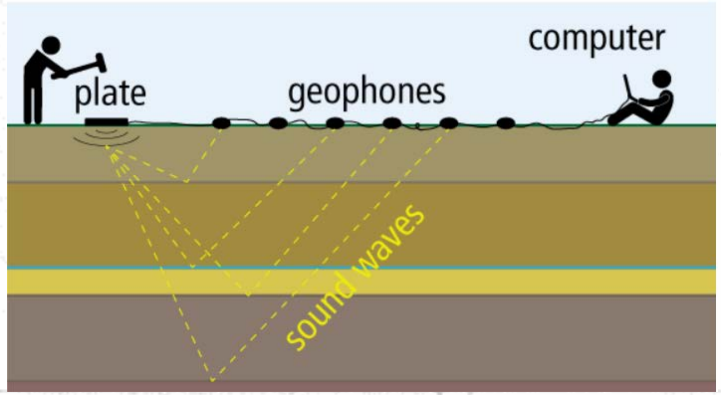
Source: Washington EMD

~70% of schools are in high seismic risk areas

Source: OSPI & DNR

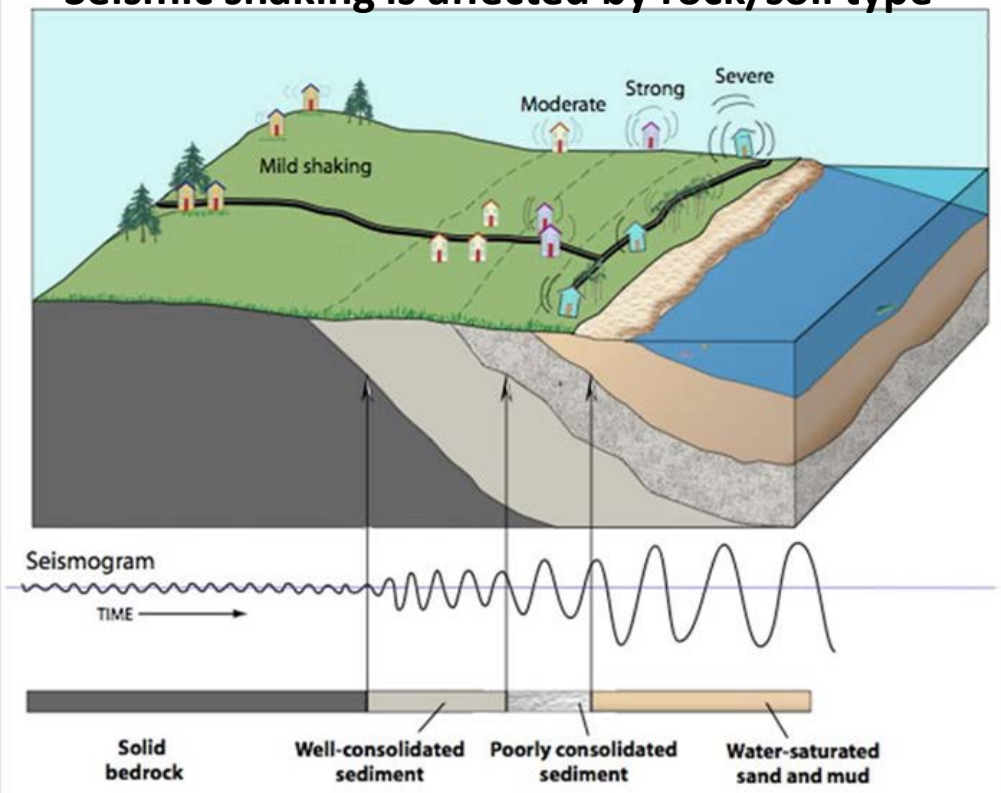
How schools were assessed - Geology

Seismic site class assessment of the soils at the facilities helps to determine the expected level of earthquake shaking. This is used in engineering calculations for seismic upgrade requirements.



NEHRP Site Class	Description	Vs30 measurement (m/s)
A	Hard rock	>1,500
B	Rock	760–1,500
C	Soft rock/ very dense soil	360–760
D	Stiff soil	180–360
E	Soft soil	<180
F	Soils requiring drilling	--

Seismic shaking is affected by rock/soil type



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Geologists also report on other mapped geologic hazards in the area that schools should be aware of.

How schools were assessed - Engineering

- Completed American Society of Civil Engineers (ASCE 41-17) Tier 1 Seismic Evaluation Checklists to determine seismic deficiencies for 220 school buildings
- Completed FEMA 154 Rapid Visual Screening evaluations for 220 school buildings
- Earthquake Performance Assessment Tool (EPAT) worksheets completed for each building
- Seismic Evaluation Reports created for each building
- Typical Tier 1 seismic evaluation costs ($0.20 to $0.50 per SF of Bldg.)

1.1 Mount Vernon, Lincoln Elementary School, Main Building

1.1.1 Building Description

Building Name:	Main Building
Facility Name:	Lincoln Elementary School
District Name:	Mount Vernon
Latitude:	48.415
Longitude:	-122.328
ICOS Object ID:	795
ICOS County/District ID:	29320
ICOS Building ID:	12009
Enrollment:	373
Gross Sq. Ft. :	40,002
Year Built:	1938
Number of Stories:	3
S_{XS} BSE-2E:	1.087
S_{X1} BSE-2E:	0.452
ASCE 41 Level of Seismicity:	High
Site Class:	C
Liquefaction Potential #1:	low to moderate
Liquefaction Potential #2:	Low to Moderate
Tsunami Risk:	None

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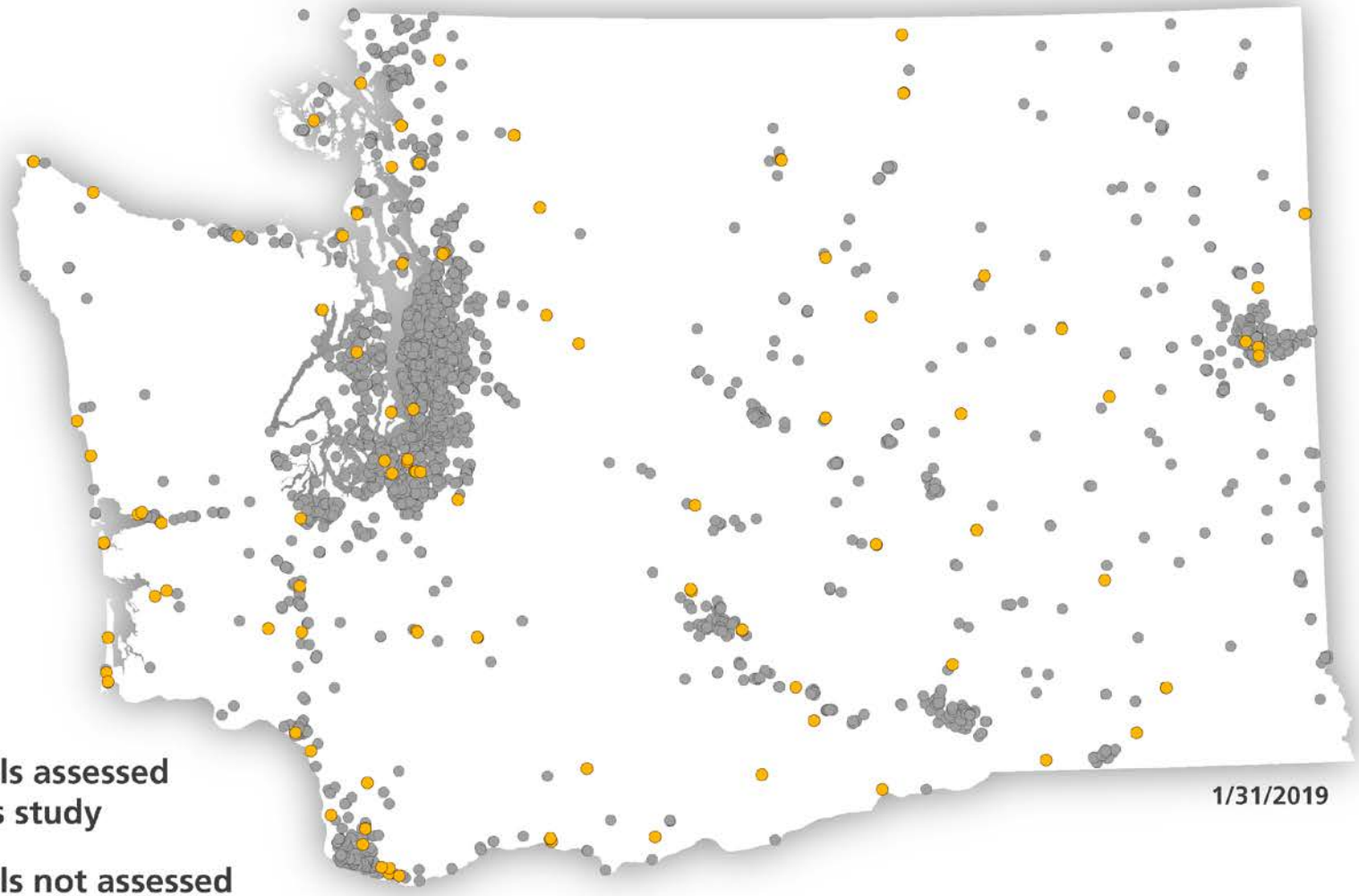
WASHINGTON STATE DEPT OF NATURAL RESOURCES
WASHINGTON GEOLOGICAL SURVEY

WASHINGTON SCHOOL SEISMIC SAFETY PROJECT

ALL SCHOOLS



School Seismic Safety Project

- schools assessed in this study
- schools not assessed in this study

1/31/2019

Collaboration between DNR and OSPI

- DNR and OSPI work together to contact the districts, engage superintendents, and get consent for schools to participate in this project.
- OSPI helped to determine the date of last major structural renovation for each building, where available.
- We work together to make sure project is on track and the data are in the right format for ICOS, so that the results can be used in school safety planning
- OSPI incorporates these data into their ICOS database and use this as a way of tracking seismic assessments

Reid Middleton Photo

School seismic safety assessment at Fife High School.

Pictured from left to right are: Corina Forson (DNR), Scott Black (OSPI), Representative Norma Smith, Glen Farley (King 5), Commissioner Hilary Franz (DNR), Dave Norman (DNR), Travis West (DNR)

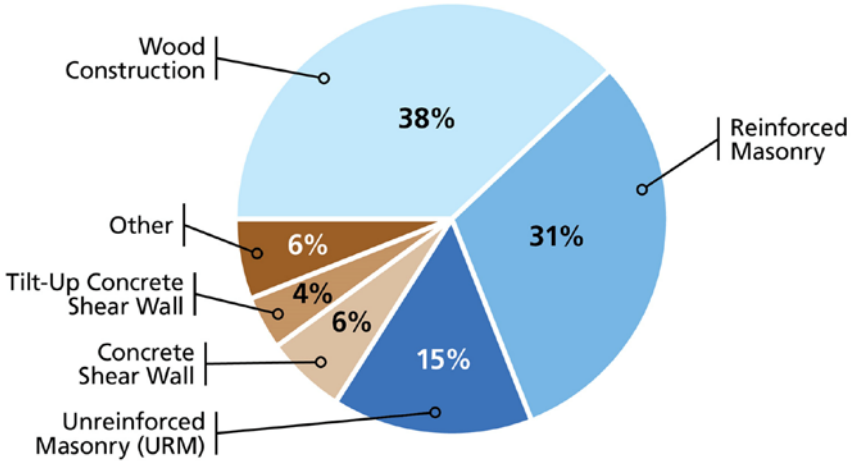
Preliminary findings of the study

- Washington State has many older school buildings built prior to the adoption of modern seismic safety codes. Older and more vulnerable construction types are more at risk of collapse.
- Unretrofitted unreinforced masonry buildings and unretrofitted buildings built prior to 1975 are especially vulnerable to collapse.
- Site class measurements showed that 30 campuses have a different measured site class from the predicted site class based on reconnaissance-scale mapping. This helps to inform detailed engineering plans and potentially reduces building costs.
- Conducting comprehensive seismic assessments provides districts with actionable information on the condition of their schools and an approximate cost to upgrade.

Study Building Stats (220 representative buildings)

Avg. Year of Construction	= 1962
Avg. Square Footage	= 25,065 SF
Avg. Occupants Per School	= 380 people
Avg. Seismic Acceleration[1]	= 0.99 g

1. Maximum-Considered Lateral Earthquake Acceleration



Building construction types from this study

Preliminary cost estimates (subject to change)

Task	Ballpark range of estimated costs per school building	Approximate cost for ~70% of WA school buildings (high seismic risk buildings)
RVS screening and geologic site assessment	~ $1,500	~$3.4 – $4.2 Million
Preliminary geologic and Tier 1 ASCE 41-17 checklist engineering assessment for each building	~$4,500 - $9,000	~$9.8 - $22.4 Million
More comprehensive Tier 2 ASCE assessment and design concept and estimated cost to retrofit for each building (costs vary and depend on construction and square footage) including geologic assessment	~$9,000 - $26,000	~$25.2 - $72.8 Million
Average cost of seismic upgrade assuming base safety objective (life-safety standard)	~$1.4 - $3.4M	~$3.8 – 9.5 Billion
Total	**~ $2.5 Million**	**~$7.2 Billion**

These values are preliminary and incorporate estimates not described here. Stay tuned for the final report for more detailed cost estimates

OSPI
School Facilities & Organization

State Investments in School Seismic Safety

SCAP funding for new school facilities meeting current seismic codes

- $11.3 Billion Dollars (2001-2018)

Future Investments - OSPI Budget Requests

Continued SCAP Funding For New Construction

Study and Survey Enhancement - $1.5 Million

- Rapid Visual Screening
- List to DNR for Site Specific Geologic Assessment

School Preservation Program $200 Million

- Planning grants to evaluate schools for safety, security and construction needs
- Provide funding for most needed projects from planning grants

OSPI
School Facilities & Organization

Information and Condition of Schools (ICOS) Pre-Disaster Mitigation (PDM) Module

PDM identifies 6 natural hazards at individual school sites across the state

- Earthquake, Tsunami, Volcanic, Fire, Flood, Landslide
- Utilizes GIS & State Hazard Maps

School Seismic Program Earthquake Assessment data

- Uploaded into Information, Condition of Schools (ICOS) Pre Disaster Mitigation (PDM) System
- Assessment Data defines the risk associated to each hazard at every school

OSPI
School Facilities & Organization

- **PDM Provides Tools For Districts**

- Safety Planning
- Short Term Facility Plans
- Long Term Facility Plans (Capital Bond Programs)
- Building level information for County Mitigation Plans
- FEMA grant funding

DNR legislative funding requests

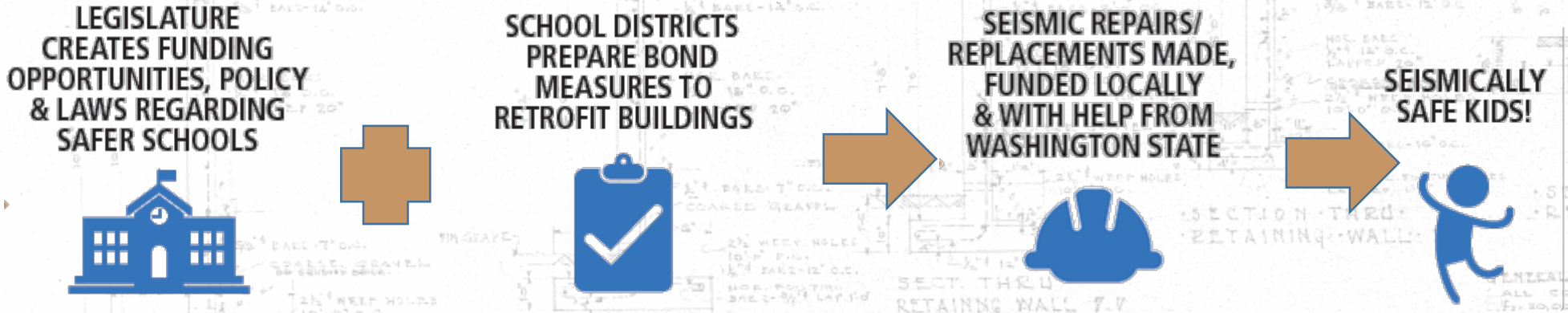
DNR is asking for $5,000,000 in the upcoming 2019–2021 Capital Budget to continue school seismic safety assessments as directed in the 2017-2019 budget allotment. We propose to use this funding to conduct comprehensive seismic assessments on approximately 400 school buildings in high-risk areas or schools that are flagged from RVS across Washington State.

This study will provide us with valuable information about costs to assess and upgrade.

Together DNR and OSPI's projects will provide schools with valuable information about the condition of their buildings and recommendations for seismic upgrades that could help to safeguard children and faculty.

Recommended next steps

- Finish this project and use results of extrapolation to prioritize future site assessments
- Fund DNR and OSPI decision packages this biennium and in the future
- Complete an inventory of all WA school districts to see where seismic upgrades have been completed and enter this information into ICOS
- Assess high risk schools for seismic and tsunami hazards considering upgrades to immediate occupancy standards for gymnasiums and potential shelter facilities
- Implement state funding opportunities to complete upgrades
- Prioritize this effort and fund it accordingly. The safety and lives of our children should be a priority and building upgrades are crucial for this



Puyallup high school after the 1949 earthquake

Thank you for providing funding for this project and for asking us to do this work session

"Children have the right to be safe in school buildings during earthquakes"

Western States Seismic Policy Council

Questions? Contact DNR or OSPI for more information

Extensive Suspended Ceiling System Collapse in High School Classroom from M7.0 Anchorage Alaska Earthquake. (Reid Middleton Photo)

Damaged Primary School in Central Mexico 2017. Wall Failure Due to Diagonal Tension in Unreinforced Masonry Bearing Wall. Many older Washington State school buildings are constructed similarly. (2017 M7.1 Central Mexico Earthquake Reconnaissance Report, Reid Middleton, Inc.)

Common Seismic Deficiencies from Engineering Database

Structural Components

- Inadequate Building Lateral Strength
- Inadequate Load Path From Roof to Foundation
- Weak Roof Edge Beam Strength
- Inadequate Cross-Roof Connections
- Inadequate Reinforcing Steel in Walls
- Walls Too Thin Compared to Height
- Roof-to-Wall Connections Not Strong Enough

Architectural Finishes and Mechanical/Electrical Components

- Inadequately Anchored or Braced Mechanical/Electrical Equipment
- Inadequately Braced Fire Sprinkler Piping and Lack of Flexible Couplings
- Poor Ceiling Clearance for Fire Sprinkler Heads
- Inadequately Supported Light Fixtures, Ceilings and Emergency Power Equipment